Tennessee Valley Authority, 400 West Summit Hill Drive, Knoxville, Tennessee 37902

May 21, 2020

Mr. Phillip Brooks (brooks.phillip@epa.gov)
Director, Air Enforcement Division
Office of Enforcement and Compliance Assurance
U.S. Environmental Protection Agency (EPA)
Ariel Rios South Building, Room 1119
1200 Pennsylvania Avenue, North West
Washington, DC 20004

Dear Mr. Brooks:

FEDERAL FACILITIES COMPLIANCE AGREEMENT (DOCKET NO. CAA-04-2010-1760) AND THE CONSENT DECREE (CIVIL ACTION NO. 3:11-CV-00170) FOR THE FACILITIES OF THE TENNESSEE VALLEY AUTHORITY (TVA) – SEMI-ANNUAL AND FINAL REPORT – WASTE HEAT RECOVERY PROJECT

As instructed in the requirements of Appendix C of the Federal Facilities Compliance Agreement (FFCA), specifically Section I paragraph B, enclosed is the semi-annual report for the subject project. TVA determined on May 11, 2020, that the Waste Heat Recovery Project was complete, so this semi-annual report also constitutes the final project report under Appendix C, Section 1, paragraph C of the FFCA. Final Reports under Section 1, paragraph C, for all other Environmental Mitigation Projects implemented under the FFCA have already been submitted. In summary, TVA spent $7,216,768 implementing this project and the lifetime emission avoidances/reductions to date are as follows: 37,183 metric tons of carbon dioxide equivalent, 28.2 tons of sulfur dioxide, 53.9 tons of nitrogen oxides, and 0.21 pounds of mercury.

This information was prepared either by me or under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my evaluation, or the direction and my inquiry of the person(s) who manage the system, or the person(s) directly responsible for gathering the information, I hereby certify under penalty of law that, to the best of my knowledge and belief, this information is true, accurate, and complete. I understand that there are significant penalties for submitting false, inaccurate, or incomplete information to EPA.

If you have questions, please contact Tracy Stanton at (865) 632-3080 or by email at tpstanton@tva.gov.

Sincerely,

Rebecca C. Tolene

Rebecca C. Tolene
Vice President, Environment
Enclosure

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FEDERAL FACILITIES COMPLIANCE AGREEMENT BETWEEN THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY AND THE TENNESSEE VALLEY AUTHORITY - DOCKET NO. CAA-04-2010-1760

Revised Waste Heat Recovery Project

Project Name:	Revised Waste Heat Recovery Project
Department:	EnergyRight® Solutions, Commercial Energy Solutions
Funding Category:	Clean/Renewable Energy Projects
Product/Process:	Development of approximately 5 MW of clean generation from industrial waste heat recovery

A. Activities Undertaken and Overall Progress of Project to Date

The Tennessee Valley Authority (TVA) received approval for the Waste Heat Recovery (WHR) Project from the United States Environmental Protection Agency (EPA) on January 22, 2013. This project was intended to utilize waste heat conversion technologies to recover existing waste heat from an industrial process and convert it to approximately 5 MW of clean electricity. TVA sought to complete this project through leveraging funds with large industrial customer(s) that have a suitable waste heat profile. TVA issued a notification to all local power companies (LPCs) and Direct Serve Industrial (DSI) customers, and LPC-served industrial customers with power demand greater than 5 MW. A Request for Proposal (RFP) was sent to interested industrial customers in the TVA service area on November 1, 2013, to solicit proposals for the design, construction, installation, and operation of a waste heat-to-electricity system to be located at the industrial customer's site. TVA received one proposal from an industrial customer (aluminum manufacturer). TVA selected the proposal, but the aluminum manufacturer withdrew its proposal on April 1, 2015, after it was acquired by another company. Later that month, TVA entered into discussions with the EPA to broaden the scope of this project to include combined heat and power (CHP) projects. CHP is defined as the simultaneous production of electricity and heat from a single fuel source, such as natural gas, biomass, biogas, or waste heat. CHP can be applied to more industrial facilities than WHR. TVA issued a revised project proposal to the EPA on June 26, 2015. A revised RFP was released by TVA on August 3, 2015, and a project overview webinar was held for interested bidders on September 16, 2015. The revised project RFP generated much interest from potential proposers. During December 2015, TVA received approval of the revised project plan from the EPA and ten proposals responding to the revised RFP. TVA must expend Project Dollars on the Revised WHR Project no later than five years from date of approval of the revised project (i.e., by December 2020). In September of 2016, TVA successfully executed contract agreements to make awards to two entities. Both entities also provided construction project plans to TVA.

The following tasks have been completed by TVA after approval of the original proposal on January 22, 2013:

1. The TVA WHR project was identified and the project implementation plan was developed.
2. Conducted market research to identify interested Valley industrial customers/sites with waste heat potential.
3. Performed a technology review of viable waste heat-to-electricity platforms.
4. Received comments and input on the draft RFP from Tennessee Technological University and University of North Carolina Clean Energy Center.
5. Conducted a project overview webinar for internal TVA stakeholders on October 17, 2013.
6. Issued the WHR RFP to local power companies and industrial customers on November 1, 2013.
7. Conducted a project overview webinar for all customers and external stakeholders on December 4, 2013.
8. Received one proposal from an aluminum manufacturing company on March 1, 2014.
9. TVA cross-functional evaluation team reviewed and evaluated the proposal, and sent a list of clarifying questions to the aluminum company on April 7, 2014, to get a better understanding of the proposed WHR project.
10. TVA cross-functional team visited the proposed project site for a comprehensive proposal presentation and plant walk-through on July 21, 2014.

11. TVA cross-functional team verified that the proposal estimated electric generation would have exceeded the required prove-out criteria for compliance with approved plan.
12. TVA cross-functional team selected the aluminum manufacturer for the WHR project on August 6, 2014.
13. TVA notified the aluminum manufacturer of its selection on August 7, 2014.
14. TVA was developing the contract which was to be issued to the aluminum manufacturer. However, prior to the finalization of this contract, TVA was notified that the aluminum manufacturer was acquired by another company. This acquisition caused the aluminum manufacturer to withdraw its proposal on April 1, 2015.
15. TVA submitted a revised project proposal, which included both WHR and CHP, to the EPA on June 26, 2015.
16. TVA issued the revised RFP to local power companies and industrial customers on August 3, 2015.
17. TVA conducted a project overview webinar for all customers and external stakeholders on September 16, 2015.
18. TVA and EPA conducted a conference call on October 13, 2015, to discuss best practices for the use of the EPA CHP Emissions Calculator.
19. TVA received EPA approval of the revised project plan and 10 proposals to the revised RFP in December 2015. The FFCA provides TVA 5 years from the date of EPA's approval of the revised plan, i.e., until December 2020, to expend Project Dollars for the completion of this project.
20. TVA team formally reviewed and scored the proposals for selection of awardee in March 2016.
21. TVA met with a potential awardee, whose project features a CHP system, on April 5, 2016.
22. TVA met with another potential awardee, whose project features CHP from biogas generated in wastewater digesters, on July 6, 2016.
23. TVA executed contract agreements with the two awardees in September 2016.
24. Project 1 – Project proponent submitted 35% design plans for TVA review and comment in March 2017.
25. Project 1- TVA completed required National Environmental Policy Act (NEPA) reviews in March 2017.
26. Project 2 – Project proponent submitted 30% design plans in July 2017 and advertised for Design Build proposal in September 2017.
27. TVA completed required NEPA reviews in April 2017
28. Project 1 placed an order for CHP equipment in August 2017 and executed a contract amendment with TVA in September 2017 to update the Project Plan.
29. Project 2 received no responses to their initial RFP opening on December 4, 2017. Project details were edited and RFP was opened on March 12, 2018. Project owner considered five proposals.
30. Bids received for Project 2 were substantially higher than anticipated. This project was withdrawn by the awardee, effective June 25, 2018, and the project funding previously awarded was returned to TVA.
31. The funds previously spent and forecasted for Project 2 was allocated to Project 1 so that TVA would spend $7,216,277 on this Revised Waste Heat Recovery Project in order to fulfill the $40 million required to be expended on Clean/Renewable Energy Projects under FFCA Appendix C, Section IV.A.
32. Project 1 – Operational status achieved on March 31, 2019.
33. Project 1 – Automated measurement and verification hardware package installed

34. Project 1 - System has proven operational stability after several months of operation. TVA project expenditure requirement was met on May 11, 2020.

Revised Project Schedule

PROJECT MILESTONES	PROJECT 1[1]
RFP issued to industrial customers (complete)	August 3, 2015
External webinar - RFP Overview (complete)	September 16, 2015
Proposals due (complete)	December 7, 2015
Evaluate proposals & meet with awardee(s) (complete)	March 2016
Award Contract (complete)	September 2016
Environmental permitting and reviews (complete)	Nov 2016 – Nov 2018
Detailed design and engineering package (complete)	Nov 2017
Design review and approval (complete)	Jan 2018
Equipment procurement (complete)	Aug 2017 - April 2018
Begin site preparation (complete)	February 2017
Begin construction, develop operating procedures (complete)	May 2017
Construction complete (complete)	September 2018
System prove-out, operator training (complete)	October 2018
Commercial operation and project completion (complete)	March 2019
Finalize measurement and verification activities (complete)	April 2019 – May 2020
Final Report to EPA	May 2020

[1]Project 2 was withdrawn by awardee in June 25, 2018.

B. Project Dollars Spent to Date

For the period of January 22, 2013, through May 11, 2020, the WHR Project has spent $7,216,768 on consultant services provided by the Industrial Energy Efficiency Network, technical reviews performed by DNV GL (KEMA), and payments to project participants. The consultant services were for the purpose of obtaining expert advice on the contents of the RFP and the technical reviews were necessary from an independent third-party perspective to determine the validity of the proposals TVA received.

TVA determined on May 11, 2020, that the Revised Waste Heat Recovery Project was complete.

Total Waste Heat Recovery	**January 22, 2013 – May 11, 2020**
Preliminary Planning	$ 49,762
Develop detailed design engineering package[1]	$ 881,296
Equipment procurement[1]	$ 3,463,133
Construction, operating procedures[1]	$ 2,554,775
System prove-out, operator training[1]	$ 267,802
Total All Tasks	**$ 7,216,768**

[1]Payments to project participant are anticipated to be applied toward these tasks.

C. Lifetime Avoided Emissions (or Emission Reductions)

For the reporting period of January 22, 2013, through May 1, 2020, emissions reductions have occurred (Measurement beginning on August 8, 2019). The estimated lifetime avoided emissions for the project are calculated using the methodology, equation and emission factors defined below.

	Lifetime Energy Reduction (MWh)	CO_{2e} metric tons	SO_2 tons	NOx tons	Hg lb
Estimated Results To Date	34,979	37,183	28.2	53.9	0.21

Note: Estimated Lifetime Energy Reduction
The approved revised project proposal estimated 832,200 MWh

Additional energy reductions are associated with heat recovery, offsetting natural gas consumption by boilers as defined below.

	Lifetime Energy Reduction (Therms)	CO_{2e} metric tons	SO_2 tons	NOx tons	Hg lb
Estimated Results To Date	5,072,360	709			

Note: Estimated Lifetime Energy Reduction

As discussed in the approved project proposal submitted to EPA, et al., in August 2012, and revised and approved by the EPA in December 2015, each installation has an expected lifetime. Analysis and verification includes periodic reviews of program performance through evaluation, measurement and verification (EM&V) assessments—an energy efficiency industry best practice. Periodic reviews are an important part of providing assurances that programs are performing as intended. EM&V results are used to periodically modify program planning assumptions based on performance validated through onsite visits, metering analyses and review of program documentation. Factors that may be adjusted through EM&V efforts include:

- Lifespan – estimate of useful life of installed efficiency measures based on observed in-service behavior and industry standards;
- Net-to-Gross (NTG) – the average of the ratio of net realized savings to gross reported savings, weighted by year. Initially, the NTG is determined through assessment of documented industry experience and, subsequently, through evaluation, measurement and verification of program results. The NTG includes factors such as free-ridership and observed savings versus estimated savings.

Ongoing evaluations of the transmission and distribution systems yield yet another factor influencing the calculation of emissions saving, transmission and distribution (T&D) losses. The effect of T&D losses is that more energy must be generated to serve the end-use consumer than what is measured at the consumer's meter to make up for energy lost in delivery through the transmission and distribution lines. Taking all these factors into account yields the following formula for calculation of Lifetime Energy Savings:

$$\frac{Cumulative\ First\ Year\ Energy\ Savings\ (kWh)}{1{,}000\ kWh/MWh} \times 1.065\ (T\&D\ Losses)\ \times NTG\ Factor\ (\%)\ \times Lifespan\ (Years)$$

Lifetime Emissions Reductions are the product of the Lifetime Energy Savings and the current emission rates:

$$Lifetime\ Energy\ Savings\ (MWh) \times \frac{Emission\ Rate\ (Tons)}{MWh} = Avoided\ Emissions\ (Tons)$$

D. Emission Factor Update and Methodology

In accordance with the requirements of the Consent Decree (CD) and FFCA, the TVA submitted in October 2011 eleven project proposals under three project categories as described in Appendix C of the FFCA. In those original proposals, the expected environmental benefits of the mitigation projects were based on a 2008 coal fleet emissions baseline for greenhouse gases (expressed as carbon dioxide equivalents, CO_2e), sulfur dioxide (SO_2), nitrogen oxides (NO_x) and mercury (Hg). These proposals were subsequently updated and ultimately approved with the 2008 coal fleet baseline.

However, as TVA retires older coal units and adds controls to existing units, the 2008 baseline no longer reflects TVA's current emissions. Therefore, the emission factors were updated based on CY2016 coal-fleet emissions to accurately report on the environmental benefits of these mitigation projects. Since the TVA System is defined in paragraph 63 of the CD and paragraph 67 of the FFCA as the existing coal fleet and any energy efficiency realized has the greatest impact to the fossil fleet versus any other generating asset, it would be appropriate to continue basing the environmental benefit of the mitigation projects on the coal fleet emissions only. To that end, the following equations were used to calculate the CY2016 emission factors:

Greenhouse Gases expressed as CO_2e:

$$CO_2e = \sum_{i=1}^{n} GHG_i \times GWP_i$$

$$CO_2e = (50{,}332{,}964.5 \text{ metric tons } CO_2)(1) + (5{,}902.02 \text{ metric tons } CH_4)(25) + (858.47 \text{ metric tons } N_2O)(298)$$

$$CO_2e = 50{,}736{,}340 \text{ metric tons}$$

$$CO_2e \text{ emission factor} = CO_2e \div \text{Net Generation (MWh)}$$

$$CO_2e \text{ emission factor} = 50{,}736{,}340 \text{ metric tons} \div 47{,}713{,}643 \text{ MWh}$$

$$CO_2e \text{ emission factor} = 1.063 \text{ metric tons/MWh}$$

where,

GHG = mass emissions of each greenhouse gas

GWP = global warming potential for each greenhouse gas

Reference: Equation A-1 of 40 CFR Part 98, Subpart A

TVA's Greenhouse Gas Report from e-GGRT (P98) was used to determine the CO_2 emissions for CY2016 for the coal fleet only.

SO_2:

$$SO_2 \text{ emission factor} = SO_2 \text{ tons} \div \text{Net Generation (MWh)}$$

$$SO_2 \text{ emission factor} = 73{,}280 \text{ tons} \div 47{,}713{,}643 \text{ MWh}$$

$$SO_2 \text{ emission factor} = 0.00154 \text{ tons/MWh}$$

where,

The SO_2 emissions for CY2016 were pulled from TVA's annual progress report as required under paragraph 136 of the CD and paragraph 144 of the FFCA.

NO_x:

$$NO_x \text{ emission factor} = NO_x \text{ tons} \div \text{Net Generation (MWh)}$$
$$NO_x \text{ emission factor} = 38{,}514 \text{ tons} \div 47{,}713{,}643 \text{ MWh}$$
$$NO_x \text{ emission factor} = 0.000807 \text{ tons/MWh}$$

where,

The NO_x emissions for CY2016 were pulled from TVA's annual progress report as required under paragraph 136 of the CD and paragraph 144 of the FFCA.

Hg:

$$\text{Hg emission factor} = \text{Hg lbs} \div \text{Net Generation (MWh)}$$
$$\text{Hg emission factor} = 282 \text{ lbs} \div 47{,}713{,}643 \text{ MWh}$$
$$\text{Hg emission factor} = 0.0000059 \text{ lbs/MWh}$$

where,

The Hg emissions for CY2016 were pulled from TVA's annual Toxic Release Inventory for the coal fleet only.

The CY2016 emission factors are summarized in the following table:

CO_2e	NO_x	SO_2	Hg
metric tons/MWh	tons/MWh	tons/MWh	lbs/MWh
1.063	0.000807	0.00154	0.0000059